F. **Aluminum Alloy Structural Plate for Pipe, Pipe Arches, and Arches.** . . . . . AASHTO M-219

830.03 PLASTIC PIPE.

A. **Plastic Pipe for Non-Pressure Drainage of Sewage and Surface Water (outside buildings).** Plastic pipe for non-pressure drainage of sewage and surface water shall meet the following:

1. **Acrylonitrile-Butadiene-Styrene (ABS).** . . . . . ASTM D-2680
2. **Acrylonitrile-Butadiene-Styrene (ABS).** . . . . . ASTM D-2751
3. **Type PSM, Polyvinyl Chloride (PVC).** . . . . . ASTM D-3034
   or. . . . . ASTM F-949
4. **Perforated, Corrugated, P.E., or Plastic Pipe.** . . . . . AASHTO M-252

B. **Plastic Pipe for Water Distribution Lines (outside buildings).** Plastic pipe for water distribution lines shall meet the following:

1. **Acrylonitrile-Butadiene-Styrene (ABS).** . . . . . ASTM D-1527 Schedules 40 and 80.
2. **Polyethylene (PE).** . . . . . ASTM D-2104, Schedule 40
3. **Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chlorid (CPVC) Plastic Pipe (SDR-PR).** The PVC and CPVC compounds shall meet ASTM D-1784 and shall be Class 12454-B (Type 1, Grade 1).
4. **Polybutylene (PB) Plastic Pipe (SDR-PR).** . . . . . ASTM D-2662

C. **Plastic Drain, Waste and Vent (DWV) Pipe and Fittings.** Plastic drain, waste, and vent pipe and fittings shall meet the following:

1. **Acrylonitrile-Butadiene-Styrene (ABS).** . . . . . ASTM D-2661
2. **Polyvinyl Chloride (PVC).** . . . . . ASTM D-2665
3. **Polyvinyl Chloride (PVC).** . . . . . ASTM D-2949

D. **Plastic Hot and Cold Water Distribution Systems (inside buildings).** Plastic hot and cold water distribution systems shall meet the following:

1. **Polybutylene (PB).** . . . . . ASTM D-3309
2. **Chlorinated Polyvinyl Chloride (PVC).** . . . . . ASTM D-2846

E. **Plastic Gas Pipe, Tubing, and Fittings.** . . . . . ASTM D-2513

F. **Corrugated Polyethylene Culverts.** . . . . . AASHTO M-294

SECTION 834
STRUCTURAL STEEL AND RELATED MATERIALS

834.01 STRUCTURAL STEEL.

A. **Structural Carbon Steel.** . . . . . AASHTO M-270, Grade 36

B. **High Strength, Low Alloy Steel.** . . . . . AASHTO M-270, Grade 50

C. **High Strength, Low Alloy Structural Steel.** . AASHTO M-270, Grade 50W AASHTO M-270, Grade 50W steel in unpainted application shall all be of the same type and from the same source.

D. **High Strength Steel Plate.** . . . . . AASHTO M-270, Grade 100

E. **Structural Steel for Pins and Rollers.** Structural steel for pins and rollers 9 inches or less in diameter shall meet either AASHTO M-102, Class C, D, F, or G; or AASHTO M-169, Grades 1016 to 1030.

834.02 MISCELLANEOUS METAL.

A. **Steel Forgings.** . . . . . AASHTO M-102, Classes C, D, F, or G

B. **Steel Castings.** This material shall meet the following requirements:

1. **Carbon Steel Castings.** . . . . . AASHTO M-192, Class 70

2. **Chromium Alloy Steel Castings.** . . . . . AASHTO M-163, Grade CA-15

C. **Gray Iron Castings.** . . . . . AASHTO M-105, Class 30

D. **Malleable Castings.** . . . . . ASTM A-47, Grade No. 35018

E. **Ductile Iron Castings.** . . . . . ASTM A-536, Grade 60-40-18

F. **Bronze Bearing and Expansion Plates.** AASHTO M-107, Alloys C-91300 or C-91100

G. **Rolled Copper Alloy Bearings and Expansion Plates.** . . . AASHTO M-108

H. **Cast Aluminum.** . . . . . AASHTO M-193

I. **Lead Sheets and Plates.** . . . . . ASTM B-29, Common Lead

J. **Brass Sheets.** . . . . . ASTM B-36

K. **Copper Sheets.** . . . . . AASHTO M-138

834.03 BOLTS, NUTS, AND WASHERS.

A. **Unfinished Regular Bolts and Nuts.** . . . . . ASTM A-307

B. **High Tensile Strength Bolts, Nuts, and Washers.**

All bolts shall meet AASHTO M-164 and these revisions.

All nuts shall meet AASHTO M-292 as applicable or AASHTO M-291 and these revisions.

All washers shall meet AASHTO M-293 and these revisions.

1. **Manufacturing.**

   a. **Bolts.**

      (1) Hardness for bolt diameters 1/2 inch to 1 inch inclusive shall be as noted below:

Bolt Size, In.	Hardness Number			
	Brinell		Rockwell C	
	Min.	Max.	Min.	Max.
1/2 to 1 inch	248	311	24	33

   b. **Nuts.**

      (1) Nuts to be galvanized (hot dip or mechanically galvanized) shall be heat treated grade 2H, DH, or DH3.

      (2) Plain (ungalvanized) nuts shall be grades 2, C, D, or C3 with a minimum Rockwell hardness of 89 HRB (or Brinell hardness 180 HB), or heat treated grades 2H, DH, or DH3.

      (3) Nuts that are to be galvanized shall be tapped oversize the minimum amount required for proper assembly. The amount of overtap in the nut shall be so the nut assembles freely on the bolt in the coated condition and shall meet the mechanical requirements of AASHTO M-291 and the rotational-capacity test herein (the overtapping requirements of AASHTO M-291, paragraph 7.4 shall be considered maximum values instead of minimum, as currently shown).

      (4) Galvanized nuts shall be lubricated with a lubricant containing a dye of any color that contrasts with the color of the galvanizing.

   c. **Marking.** All bolts, nuts, and washers shall be marked according to the appropriate AASHTO Specifications.

2. **Testing.**

   a. **Bolts.**

      (1) Proof load tests (ASTM F-606, Method 1) are required. Minimum frequency of tests shall be as specified in AASHTO M-164, paragraph 9.2.4.

      (2) Wedge tests on full size bolts (ASTM F-606 paragraph 3.5) are required. If bolts are to be galvanized, tests shall be performed after galvanizing. Minimum frequency of tests shall be as specified in AASHTO M-164, paragraph 9.2.4.

      (3) If galvanized bolts are supplied, the thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats, or top of bolt head.

   b. **Nuts.**

      (1) Proof load tests (ASTM F-606, paragraph 4.2) are required. Minimum frequency of tests shall be as specified in AASHTO M-292,

paragraph 7.1.2.1. If nuts are to be galvanized, tests shall be performed after galvanizing, overtapping, and lubricating.

(2) If galvanized nuts are supplied, the thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats.

c. **Washers.**

(1) If galvanized washers are supplied, hardness testing shall be performed after galvanizing. (Coating shall be removed before taking hardness measurements.)

(2) If galvanized washers are supplied, the thickness of the zinc coating shall be measured.

d. **Assemblies.**

Rotational-capacity tests are required and shall be performed on all black or galvanized (after galvanizing) bolt, nut, and washer assemblies by the manufacturer or distributor prior to shipping. Washers are required as part of the test even though they may not be required as part of the installation procedure.

The following shall apply:

(1) Except as modified herein, the rotational-capacity test shall be performed according to AASHTO M-164.

(2) Each combination of bolt production lot, nut lot, and washer lot shall be tested as an assembly. Where washers are not required by the installation procedures, they need not be included in the lot identification.

(3) A rotational-capacity lot number shall be assigned to each combination of lots tested.

(4) The minimum frequency of testing shall be two assemblies per rotational-capacity lot.

(5) The bolt, nut, and washer assembly shall be assembled in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device. For short bolts which are too short to be assembled in the Skidmore-Wilhelm Calibrator, see Section 834.03 B.2.d.9.

(6) The minimum rotation, from a snug tight condition (10% of the specified proof load), shall be:

240 degrees (2/3 turn) for bolt lengths < 4 diameters.
360 degrees (1 turn) for bolt lengths > 4 diameters and < 8 diameters.
480 degrees (1 1/3 turn) for bolt lengths > 8 diameters.

(7) The tension reached at the above rotation shall be equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn seat are shown below:

Diameter (In.)	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/8**	**1 1/4**	**1 3/8**	**1 1/2**
Req. Installation Tension (kips)	12	19	28	39	51	56	71	85	103
Turn Test Tension (kips)	12	22	32	45	59	64	82	98	118

(8) After the required installation tension listed above has been exceeded, one reading of tension and torque shall be taken and recorded. The torque value shall meet the following:

Torque: less than or equal to 0.25 PD

Where:

Torque = measured torque (foot-pounds)
P = measured bolt tension (pounds)
D = bolt diameter (feet)

(9) Bolts that are too short to test in a Skidmore-Wilhelm Calibrator may be tested in a steel joint. The tension requirement of Section 834.03 B.2.d.7 need not apply. The maximum torque requirement of Section 834.03 B.2.d.8 shall be computed using a value of P equal to the turn test tension shown in the table in Section 834.03 B.2.d.7.

e. **Reporting.**

(1) The results of all tests (including zinc coating thickness) required herein and in the appropriate AASHTO Specifications shall be recorded on the appropriate document.

(2) Location where tests are performed and date of tests shall be reported on the appropriate document.

f. **Witnessing.**

The tests need not be witnessed by an inspection agency; however, the manufacturer or distributor that performs the tests shall certify that the results recorded are accurate.

3. **Documentation.**

a. **Mill Test Report(s) (MTR).**

(1) MTR shall be furnished for all mill steel used in the manufacture of bolts, nuts, or washers.

(2) MTR shall indicate the place where the material was melted and manufactured.

b. **Manufacturer Certified Test Report(s) (MCTR).**

(1) The manufacturer of the bolts, nuts, and washers shall furnish test reports (MCTR) for the item furnished.

(2) Each MCTR shall show the relevant information required according to Section 834.03 B.2.e.

(3) The manufacturer performing the rotational-capacity test shall include on the MCTR:

(a) The lot number of each of the items tested.

(b) The rotational-capacity lot number as required in Section 834.03 B.2.d.3.

(c) The results of the tests required in Section 834.03 B.2.d.

(d) The pertinent information required in Section 834.03 B.2.e.2.

(e) A statement that MCTR for the items meet this specification and the appropriate AASHTO specification.

(f) The location where the bolt assembly components were manufactured.

c. **Distributor Certified Test Report(s) DCTR.**

(1) The DCTR shall include MCTR above for the various bolt assembly components.

(2) The rotational-capacity test may be performed by a distributor (in lieu of a manufacturer) and reported on the DCTR.

(3) The DCTR shall show the results of the tests required in Section 834.03 B.2.d.

(4) The DCTR shall also show the pertinent information required in Section 834.03 B.2.e.2.

(5) The DCTR shall show the rotational-capacity lot number as required in Section 834.03 B.2.d.3.

(6) The DCTR shall certify that the MCTR are conforming to this specification and the appropriate AASHTO specifications.

4. **Shipping.**

a. Bolts, nuts, and washers (where required) from each rotational-capacity lot shall be shipped in the same container. If there is only one production lot number for each size of nut and washer, the nuts and washers may be shipped in separate containers. Each container shall be permanently marked with the rotational-capacity lot number such that identification will be possible at any stage prior to installation.

b. The appropriate MTR, MCTR, or DCTR shall be supplied to the Engineer for acceptance prior to installation.

C. **Direct Tension Indicators.** . . . . . ASTM F-959

834.04 PERMANENT METAL CONCRETE FORMS.

Permanent metal forms for concrete floor slabs shall be of zinc-coated (galvanized) steel sheets meeting ASTM A 446 (Grades A through E) with coating class of G165 according to ASTM A 525.

SECTION 836
REINFORCING STEEL

836.01 HEAT NUMBERS.

All reinforcement delivered to a Project shall be tagged with a metal or plastic tag showing the manufacturer's heat number. Numbers shall be embossed, engraved, or printed in waterproof ink.

836.02 BARS.

A. **Deformed and Plain Billet Bars for Concrete Reinforcement.** . . . . . AASHTO M-31, Grade 40 or 60

B. **Epoxy Coated Reinforcing Bars.** . . . . . AASHTO M-284

C. **Fabricated Steel Bar or Rod Mats for Concrete Reinforcement.** . . . . . AASHTO M-54, Grade 40 or 60

836.03 WIRES.

A. **Welded Deformed Steel Wire Fabric.** . . . . . AASHTO M-221

B. **Deformed Steel Wire for Concrete Reinforcement.** . . . . AASHTO M-225

C. **Welded Steel Wire Fabric.** . . . . . AASHTO M-55

D. **Cold Drawn Steel Wire for Concrete Reinforcement.** . . . AASHTO M-32

E. **High Tensile Wire Strand and Bars.**

1. **Post-tensioning Steel.** For the post-tensioning method of construction, the prestressing steel shall be high-tensile wire, high-tensile wire strand or rope, or high-tensile alloy bars, uncoated and stress relieved.

   High-tensile wire shall meet AASHTO M-204 and high-tensile wire strand or rope shall meet AASHTO M-203. High-tensile alloy bars shall meet AASHTO M-275.